Subject-Specific Competencies for Beginning Teachers in Missouri:Mathematics

Abbreviations used in this document for coding:

A. **1997 SSC: 2.1** = 1997 Subject Specific (Mathematics) Competencies for the Beginning Teacher in Missouri Strand 2 (Number Operation), Competency #1 (understand properties of real numbers, including equivalent representations)

B. **CR** = Missouri Certification Requirement

C. **ACEI: Standard 2c** = Association for Childhood Educational International Standard 2c: Mathematics

2c. Mathematics--Candidates know, understand, and use the major concepts, procedures, and reasoning processes of mathematics that define number systems and number sense, geometry, measurement, statistics and probability, and algebra in order to foster student understanding and use of patterns, quantities, and spatial relationships that can represent phenomena, solve problems, and manage data;

Supporting explanation

Candidates are able to teach elementary students to explore, conjecture, and reason logically using various methods of proof; to solve non-routine problems; to communicate about and through mathematics by writing and orally using everyday language and mathematical language, including symbols; to represent mathematical situations and relationships; and to connect ideas within mathematics and between mathematics and other intellectual activity. They help students understand and use measurement systems (including time, money, temperature, two and three dimensional objects using non-standard and standard customary and metric units); explore pre-numeration concepts, whole numbers, fractions, decimals, percents and their relationships; apply the four basic operations (addition, subtraction, multiplication, and division) with symbols and variables to solve problems and to model, explain, and develop computational algorithms; use geometric concepts and relationships to describe and model mathematical ideas and real-world constructs; and formulate questions, and collect, organize, represent, analyze, and interpret data by use of tables, graphs, and charts. They help elementary students identify and apply number sequences and proportional reasoning, predict outcomes and conduct experiments to test predictions in real-world situations; compute fluently; make estimations and check the reasonableness of results; and select and use appropriate problem-solving tools, including mental arithmetic, pencil-and-paper computation, a variety of manipulatives and visual materials, calculators, computers, electronic information resources, and a variety of other appropriate technologies to support the learning of mathematics. Candidates know and are able to help students understand the history of mathematics and contributions of diverse cultures to that history. They know what mathematical preconceptions, misconceptions, and error patterns to look for in elementary student work as a basis to improve understanding and construct appropriate learning experiences and assessments.

D.**NCTM** = National Council of Teachers of Mathematics

E. **MAA** = Mathematical Association of America guidelines as printed in "A Call for Change: Recommendations for the Mathematical Preparation of Teachers in Mathematics," Mathematical Association of America Committee on the Mathematical Education of Teachers, James R.C. Leitzel, editor, 1991

F. **M 1,4** = *Show Me* Mathematics Content Knowledge Standards, Standards 1 and 4;
G 2.1 = Show Me Process/Performance Standards, Standard 1

The beginning (preservice) mathematics teacher will demonstrate knowledge of and/or competency in the following areas of study:

<table>
<tr><th>For the teacher of:</th><th>Grades 1-6</th><th>Grades 5-9</th><th>Grades 9-12</th></tr>
<tr><td rowspan="14">1: Mathematical Processes and Tools: The beginning teacher of mathematics understands mathematical process and tools, and makes these aspects of subject matter meaningful for students. 1997 SSC: 1; CR 1-4, a-h</td><td colspan="3">1 use problem solving to investigate and understand mathematical content. (G 1.2, 3.5-6; ACEI 2c; NCTM P1.1.1, M1.1.1, S1.1.1; MAA I.2)</td></tr>
<tr><td colspan="3">2 communicate mathematical ideas in writing and orally, using mathematical language and symbols. (G 2.1, 4.1; ACEI 2c; NCTM P1.2.1, M1.2.1, S1.2.1; MAA I.2, I.3)</td></tr>
<tr><td colspan="3">3 develop and evaluate mathematical conjectures and arguments to explain and validate mathematical reasoning. (ACEI 2c; NCTM P1.3, M1.3, S1.3; MAA I.1, IV.2, IV.7)</td></tr>
<tr><td colspan="3">4 use mathematical modeling to simulate events and occurrences. (G 1.8, 3.2; ACEI 2c; NCTM M1.5, S1.5.4, S1.5.11; MAA I.4)</td></tr>
<tr><td colspan="3">5 analyze and articulate connections within mathematics (G 1.6; ACEI 2c; NCTM P1.4.2, M1.4.2, S1.4.2; MAA I.2)</td></tr>
<tr><td colspan="3">6 analyze and articulate connections of mathematics to other disciplines through applications (G 2.4; ACEI 2c; NCTM P1.4.2, M1.4.2, S1.4.2; MAA I.2)</td></tr>
<tr><td colspan="3">7 understand historical development of mathematics, including the contributions of under-represented groups and diverse cultures. (G 2.3, 2.4; ACEI 2c; NCTM P1.7, M1.8, S1.7; MAA I.6, II.2, IV.1, IV.2)</td></tr>
<tr><td colspan="3">8 use manipulatives to model and explain mathematical concepts. (G 1.4, 4.1; ACEI 2c; NCTM P1.7, M1.8, S1.7; MAA I.6, III.2, IV.1, IV.2)</td></tr>
<tr><td colspan="3">9 articulate the dynamic nature of mathematics and its significant role in social, cultural, and economic development. (G 1.6, 1.10, 4.1; ACEI 2c; NCTM S1.4.1; MAA I.3, I.6)</td></tr>
<tr><td colspan="3">10 use calculators and computers as tools to generate multiple representations of mathematical concepts. (ACEI 2c; MAA I.5)</td></tr>
<tr><td>11 demonstrate facility with technological tools to support geometric construction/investigation, graphing, pattern exploration, and data investigation. (G 2.7; ACEI 2c; NCTM P2.3, M2.2, S2.2; MAA I.5)</td><td colspan="2">12 demonstrate facility with technological tools to support geometric construction/investigation, graphing, matrix exploration, and data investigation. (G 2.7; ACEI 2c; NCTM P2.3, M2.2, S2.2; MAA I.5)</td></tr>
<tr><td colspan="3">13 understand and articulate the role of technology in supporting the development of mathematical understanding. (G 1.4; ACEI 2c; NCTM P1.6.1, P1.6.2, M1.7.2, S1.6.1, S1.6.2)</td></tr>
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2: Number Operation: The beginning teacher of mathematics understands numbers and their operations and makes these aspects of subject matter meaningful for students. **1997 SSC: 2; CR 1 2, b, c**	1 understand properties of real numbers, including equivalent representations. (M.1; ACEI 2c; NCTM P1.6.1, M1.7.1, M1.7.2, S1.6.1, S1.6.2; MAA II.1, III.1)	2 understand properties of real and complex numbers, including equivalent representations of numbers (M 1, 5; ACEI 2c; NCTM P2.2.2, M1.6.1, S1.5.1; MAA II.1, III.1, IV.1)
	3 analyze effects of and relationships among operations on real numbers, including place value (e.g., how place value permits efficient representation of whole numbers and finite decimals; that the value of each place is ten times larger than the value of the next place to the right; implications of place value for ordering numbers, estimation, and approximation; the relative magnitude of numbers) and concepts of integers and rationals (e.g., definitions of integer and rational number; a sense of their relative size; how operations on whole numbers extend to integers and rational numbers; and the behavior of units under the operations) (M1; ACEI 2c; NCTM P1.5.1, P1.5.4; MAA II.1)	4 analyze the effect of and relationships among operations on real and complex numbers. (M.1; ACEI 2c; NCTM P1.5.4; MAA II.1)
	5 use estimation in working with quantities, measurement, computation, and problem solving. (M.1; ACEI 2c; NCTM P1.5.10; MAA II.1)	
	6 develop, use, model, and explain computational algorithms, including multi-digit calculations involving standard algorithms, Amental math,@ and non-standard methods commonly created by students, the reasoning behind the procedures, how the base-10 structure of a number is used in these calculations. (M.1; ACEI 2c; NCTM P1.5.10; MAA II.1)	

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<tr><td rowspan="2"></td><td colspan="2">7 understand and apply numerical computation techniques (mental, paper/pencil, calculator) and extend them to algebraic expressions. (M 2; ACEI 2c; NCTM P1.5.3, M1.6.2, S1.5.3)</td></tr>
<tr><td colspan="2">8 understand a large repertoire of interpretations of addition, subtraction, multiplication, and division and of ways they can be applied.</td></tr>
<tr><td rowspan="6">3 Geometry and Measurement: The beginning teacher of mathematics understands the central concepts, tools of inquiry, and structures of geometry and measurement and makes these aspects of subject matter meaningful for students.
1997 SSC:3; CR 3</td><td colspan="2">1 understand and apply various systems and tools of measurement and the process of measurement (e.g., understanding the idea of a unit and the need to select a unit appropriate to the attribute being measured, knowing the standard [English and metric] systems of units, understanding that measurements are approximate and that different units affect precision, comparing units and converting measurements from one unit to another. (M 2; ACEI 2c; NCTM P1.5.5, M1.6.3, S1.5.3)</td></tr>
<tr><td colspan="2">2 understand and apply Euclidean geometric concepts, properties, and relationships to describe and model mathematical ideas in real-world constructs, including technical vocabulary and the role of mathematical definition. (M 2; ACEI 2c; NCTM P1.5.6, M1.6.4, S1.5.4; MAA III.2)</td></tr>
<tr><td colspan="2">3 identify, describe, measure, compare, classify, and represent two- and three-dimensional figures. (M 2; ACEI 2c; MAA II.2)</td></tr>
<tr><td>n/a</td><td>4 understand and apply trigonometric concepts, properties, and relationships. (M 2; ACEI 2c; MAA III.2)</td></tr>
<tr><td>5 understand and apply concepts of motion in two-dimensional space through transformations, including familiarity with projections, cross-sections, and decompositions of common two-dimensional shapes (M 2; ACEI 2c; MAA III.2)</td><td>6 understand and apply concepts of motion in two- and three-dimensional space through transformations, including familiarity with projections, cross-sections, and decompositions of common two- and three-dimensional shapes; representing three-dimensional objects in two dimensions and constructing three-dimensional objects from two-dimensional representations. (M2; ACEI 2c; MAA III.2)</td></tr>
<tr><td>n/a</td><td>7 perform geometric constructions using straight-edge and compass and prove that constructions yield the desired result. (M 2; ACEI 2c; NCTM M1.6.4, P1.5.4; MAA II.2)</td></tr>
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<tr><td rowspan="5">4 Data Analysis, Probability, and Statistics: The beginning teacher of mathematics understands the central concepts, tools of inquiry, and structures of data analysis, probability, and statistics and makes these aspects of subject matter meaningful for students.
1997 SSC:4; CR e</td><td colspan="2">1 collect, organize, and display data in meaningful form(s) by describing data (e.g., understanding shape, spread, and center; using different forms of representation; comparing two sets of data) (M 3, 1.8, 2.1; ACEI 2c; NCTM P1.5.7, M1.6.5, S1.5.5; MAA II.4, III.4, IV.4)</td></tr>
<tr><td colspan="2">2 use experimental and theoretical probabilities as appropriate to formulate and solve problems involving uncertainty. (M 3, 1.8, 2.1; ACEI 2c; NCTM P1.5.8, M1.6.5, S1.5.6; MAA II.4, III.4, IV.4</td></tr>
<tr><td>3 use descriptive statistics (e.g., measures of central tendency and dispersion) to analyze data and to make predictions and decisions; choose among representations and summary statistics to communicate conclusions; understand variability; understand some of the difficulties arising in sampling and inference. (M 3; ACEI 2c; NCTM P1.5.8; MAA II.4)</td><td>4 use descriptive statistics (e.g., measures of central tendency and dispersion) and inferential statistics (e.g., hypothesis testing) to analyze data and to make predictions and estimations; choose among representations and summary statistics to communicate conclusions; understand variability; understand some of the difficulties arising in sampling and inference. (M 3, 3.5; ACEI 2c; NCTM M1.6.5, S1.5.5; MAA III.4, IV.4)</td></tr>
<tr><td colspan="2">5 understand the kinds of questions that can be addressed by data, create data sets, and move back and forth between the question (i.e., the purpose of the study) and its design.</td></tr>
<tr><td rowspan="5">5 Patterns, Functions, & Relationships: The beginning teacher of mathematics understands patterns, functions, and relationships and makes these aspects of subject matter meaningful for students.
1997 SSC:5; CR 1-4, a-h</td><td colspan="2">1 identify and describe patterns and relationships. (M 4, 1.6; ACEI 2c; NCTM P1.3; MAA II.3)</td></tr>
<tr><td colspan="2">2 represent and justify patterns and functions in multiple ways, including reading and creating graphs of functions; reading and creating formulas (in closed and recursive forms) and tables; and understanding the characteristics of particular classes of functions on integers. (M 4, 1.6, 2.2, 3.4; ACEI 2c; NCTM P1.5.9, M1.6.6, S1.5.7; MAA I.3, II.3, IV.3, III.3)</td></tr>
<tr><td colspan="2">3 discover and analyze functional relations which arise from diverse problem situations. (ACEI 2c; NCTM E1.4.1)</td></tr>
<tr><td colspan="2">4 represent and justify general arithmetic claims, using a variety of representations including algebraic notation; understand different forms of argument; and devise deductive arguments.</td></tr>
<tr><td colspan="2">5 use algebraic notation to represent calculation, to express identities, and to solve problems. (M 4; ACEI 2c; MAA II.3)</td></tr>
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	n/a	6 use basic trigonometric relations including graphic representation and real-world application. (M 4)	
	N/a		7 use trigonometric equations and inequalities to solve problems. (M4)
6 Mathematical Systems: The beginning teacher of mathematics understands the central concepts, tools of inquiry, and structures of mathematical systems and makes these aspects of subject matter meaningful for students. **1997 SSC:6; CR 2, 3, h**	n/a	1 construct logical proofs to validate or refute mathematical conjectures. (M 4)	
	n/a	2 understand the nature and purpose of axiomatic systems, including field axioms (e.g., recognizing commutativity, associativity, distributivity, identities, and inverses as properties of operations on a given domain; seeing computation algorithms as applications of particular axioms; and appreciating that a small set of rules governs all of arithmetic) (M 5; NCTM M1.6.7, S1.5.8)	
	N/a		3 understand and apply the major concepts of linear and abstract algebra. (M 5; NCTM S1.5.8; MAA III.3)
7 Discrete Mathematics: The beginning teacher of mathematics understands the central concepts, tools of inquiry, and structures of discrete mathematics and makes these aspects of subject matter meaningful for students. **1997 SSC:7; CR 1-4, b, d-f**	1 use a variety of counting techniques and principles (e.g., permutations and combinations). (M 6; ACEI 2c; NCTM S1.5.10; MAA IV.6)		
	2 identify, model, and analyze situations represented by discrete and continuous data. (M 6; ACEI 2c; NCTM P, M, S1.5.10)		
	n/a	3 represent problem situations using discrete structures (e.g., sets, finite graphs, matrices, sequences, and recurrence relations). (M 6; NCTM S1.5.10; MAA IV.6)	
	N/a		4 understand and use algorithmic and recursive techniques in solving problems. (M 6; NCTM M1.6.9; MAA IV.6)

	N/a		5 represent and solve problems using linear programming and difference equations. (M 6; NCTM S1.5.10; MAA IV.6)
8 Concepts of Calculus: The beginning teacher of mathematics understands the central concepts, tools of inquiry, and structures of the calculus and makes these aspects of subject matter meaningful for students. **1997 SSC:8; CR 1, d**	n/a	1 understand and apply basic calculus concepts (e.g., evaluation of limits) to solve a variety of applied problems. (NCTM M1.6.1, S1.5.1; MAA III.1)	2 understand and apply the concepts of limit, continuity, differentiation, integration, and other continuous processes. (G 2.2; NCTM S1.5.9; MAA IV.3, IV.5)
	N/a		3 use properties and techniques of calculus to model two- and three-dimensional phenomena. (G 2.2; NCTM S1.5.9; MAA IV.5)
	N/a		4 understand and apply infinite sequences, infinite series, and power series. (NCTM S1.5.1; MAA III.1)